Hartebeesthoek Radio Astronomy Observatory (HartRAO)

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Abstract

HartRAO provides the only fiducial geodetic site in Africa, and it participates in global networks for VLBI, GNSS, SLR, and DORIS (located at the adjoining Satellite Application Centre). This report provides an overview of the resumption of geodetic VLBI activities on the 11th of August 2010 after the repair of the 26-m radio telescope.

1. Geodetic VLBI at HartRAO

Hartebeesthoek is located 65 kilometers northwest of Johannesburg, just inside the provincial boundary of Gauteng, South Africa. The nearest town, Krugersdorp, is 32 km distant. The telescope is situated in an isolated valley which affords protection from terrestrial radio frequency interference. HartRAO uses a 26-meter equatorially mounted Cassegrain radio telescope built by Blaw Knox in 1961. The telescope was part of the NASA deep space tracking network until 1974 when the facility was converted to an astronomical observatory. The telescope is co-located with an ILRS SLR station (MOBLAS-6), an IGS GNSS station (HRAO), and an IDS DORIS station (HBMB) at the adjoining Satellite Application Centre (SAC) site.

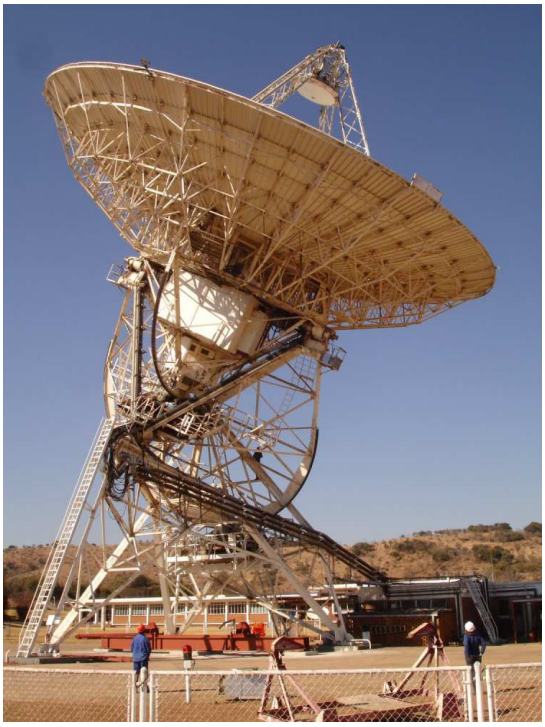

Figure 1. The 26-m drives again: on the 20th of July 2010 at 10h35 SAST the HartRAO 26-m telescope was driven for the first time since the 3rd of October 2008's breakdown due to the failure of the south polar bearing.

2. Technical Parameters of the 26-m Telescope of HartRAO

Table 1 contains the technical parameters of the HartRAO radio telescope and the Karoo Array Telescope (KAT) prototype, XDM (eXperimental Development Model), while Table 2 contains technical parameters of the HartRAO 26-m radio telescope's receivers. The data acquisition system consists of a Mark IV terminal and a Mark 5A recorder.

Table 1. Antenna parameters.

Parameter	**HartRAO-26 m**	**KAT 15-m XDM**
Owner and operating agency	HartRAO	HartRAO
Year of construction	1961	2007
Radio telescope mount	Offset equatorial	Az-El
Receiving feed	Cassegrain	Prime focus
Diameter of main reflector d	$25.914\,m$	$15\,m$
Focal length f	$10.886\,m$	$7.5\,m$
Focal ratio f/d	0.424	0.5
Surface error of reflector	$0.5\,mm$	$\sim 2.5\,mm$
Short wavelength limit	$1.3\,cm$	$2\,cm$
Pointing resolution	0.001°	0.001°
Pointing repeatability	0.004°	not tested
Slew rate on each axis	HA: $0.5^\circ\ s^{-1}$	Az: $2^\circ\ s^{-1}$
	Dec: $0.5^\circ\ s^{-1}$	El: $1^\circ\ s^{-1}$

Table 2. 26-m receiver parameters with dichroic reflector (DR), used for simultaneous S-X VLBI, off or on.

Parameter	**X-band**	**S-band**
Feeds	dual CP conical	dual CP conical
Amplifier type	cryo HEMT	cryo HEMT
T_{sys} (DR off) (K)	60	44
T_{sys} (DR on) (K)	70	50
S_{SEFD} (DR off) (Jy)	684	422
S_{SEFD} (DR on) (Jy)	1330	1350
Point source sensitivity (DR off) (Jy/K)	11.4	9.6
Point source sensitivity (DR on) (Jy/K)	19	27
3 dB beamwidth $(^\circ)$	0.092	0.332

3. Staff Members Involved in VLBI

Table 3 lists the HartRAO station staff who are involved in geodetic VLBI. Jonathan Quick (VLBI friend) provides technical support for the Field System as well as for hardware problems.

Table 3. Staff supporting geodetic VLBI at HartRAO.

Name	Function	Program
Ludwig Combrinck	Program Leader	Geodesy
Jonathan Quick	Hardware/Software	Astronomy
Jacques Grobler	Operator	Technical
Lerato Masongwa	Operator	Technical
Marisa Nickola	Logistics/Operations	Geodesy
Pieter Stronkhorst	Operator	Technical

4. Current Status

On the 3rd of October 2008 the HartRAO 26-m radio telescope suffered a critical failure of its south polar shaft bearing, bringing all observing to a halt and thereby any further participation in geodetic VLBI sessions.

The bearing is located on the main polar drive shaft, which carries the 26-m's 200-tonne moving structure. General Dynamics was contracted to replace the failed bearing. An A-frame jacking support had to be constructed to hold up the telescope structure above the polar shaft in order to replace the bearing. On the 23rd of March 2010 groundbreaking for the erection of the A-frame took place, and on the 30th of June the telescope structure was lifted to remove the polar shaft's south end cap. The bearing's inner race had failed, and fragments of it were still being removed over the following week. On the 15th of July the new bearing was in place, and the next day the end cap was back on and the A-frame came down.

On the 20th of July the 26-m drove again for the first time in over 21 months. The first post-repair geodetic session was the ICRF experiment, CRF60, on the 11th of August 2010. Appropriately, HartRAO's 26-m was joined again by the Hobart 26-m, the same telescope which partenered us in our last pre-repair geodetic session, the Deep South experiment, CRDS49, on the 16th of September 2008. During 2010 HartRAO participated in 18 experiments (Table 4).

Table 4. Geodetic VLBI experiments HartRAO participated in during 2010.

Experiment	Number of Sessions
R1	12
RDV	4
CRF	1
T2	1
Total	18

During the breakdown the 26-m's receivers were serviced and updated. Conversion of the 15-m XDM KAT prototype to be able to do geodetic VLBI to supplement the 26-m continued. A coaxial S/X (2.3+8.4GHz) cryogenic receiver needs to be fitted to the antenna. Prototyping has been followed by construction of the operational S/X feeds.

The first wide-band e-VLBIs linking Africa with Europe (at 1024 Mbps) and Australia (at 512 Mbps) were carried out during the latter part of 2010.

Figure 2. The new bearing is in place. (Credit: M. Gaylard)

Figure 3. Test assembly of the XDM's S/X feeds and receiver.

Figure 4. The old fragmented bearing on display in the foyer.

Figure 5. GNSS installation at Hamburg. (Credit: L. Combrinck)

5. Future Plans

With the prospect of 15 days' continuous observing during the CONT11 campaign in September 2011, the 26-m will be tested to the limit again. Conversion of the 15-m XDM (KAT prototype) for use in geodetic VLBI experiments will continue during 2011. We are looking forward to the acquisition of a Mark 5B+ recorder early in 2011.

During April 2010, a Global Navigation Satellite System (GNSS) was installed for troposphere calibration at Hamburg in the Eastern Cape. Similar GNSS installations are planned for Willowmore, also in the Eastern Cape, as well as Klerefontein in the Northern Cape during 2011. The construction of a Lunar Laser Ranger (LLR) housing is planned for early 2011.

The Space Geodesy Programme is an integrated program, combining VLBI, SLR, and GNSS, and it is active in several collaborative projects with GSFC, JPL, and GFZ (Potsdam) as well as numerous local institutes. Collaboration also includes CNES/GRGS/OCA and the ILRS community in a Lunar Laser Ranger (LLR) project with local support from the University of Pretoria and the National Laser Centre (CSIR), among others. General information as well as news and progress on Geodesy and related activities can be found at `http://geodesy.hartrao.ac.za/`.